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(54) Title: METHOD OF TREATING A BASE MATERIAL FOR OBTAINING SPECIFIC PROPERTIES

(57) Abstract

Method of treating a base material for obtaining one or more specific properties by diffusing a specific substance into the base material, said substance directly or indirectly inducing the specific property or properties. Said base material can be a synthetic or natural polymer, a ceramic material, an oil or grease–like substance, a gel, a paste, a glass–like substance, a liquid, a coating, a composition of materials, comprising a multilayer system of substances, a fractal composition of substances, or a composite. Said base material is contacted with an electrically conductive medium, and the specific substance is diffused in the base material under the influence of an electric field being applied across the whole of base material, electrically conductive medium and specific substance. The specific properties arising from diffusion of the specific substance in the base material are directly or indirectly induced by the introduced substance, or by the diffusion, or by a combination of both.

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Method of treating a base material for obtaining specific properties.

The invention relates to a method of treating a base material for obtaining one or more specific properties by diffusing a specific substance into the base material, said substance directly or indirectly inducing the specific property or properties.

Diffusing a foreign material into a base material in order to modify it, is known per se. Among other things, doping of semiconductors in order to give them a p- or n-type conductivity is known. There, diffusing of "impurities" takes place from the gas phase.

According to the invention, it has been found, that with the help of an electric field, it is possible to diffuse specific substances situated in a base material situated in said electric field in such a way, that said material obtains new or changed properties. Said properties can be inherent to the introduced specific substances, or be the result of the introduction of said substances or of the process of introduction. The properties comprise the physical structure, the optical properties, selective permeability for gases (membrane action), chemical properties, thermal properties, mechanical properties, such as bending and tensile strength, electric properties and magnetical properties.

The invention provides for a method such as defined in the precharacterizing portion, characterized in that the base material is contacted with an electrically conductive medium, and that the specific substance is diffused into and/or reacts in the base material under the influence of an electric field being applied across the whole of said base material, electrically conductive medium and specific substance.

Surprisingly, it has turned out, that an electric field is capable of causing substances to diffuse faster into base

materials situated in said field. Faster diffusion is also understood to comprise injection. It is also understood to comprise a process in which electrochemical reactions at the base material play an essential role in the diffusion and inducing casu quo changing of properties. In all cases, an electric field should be applied over the base material at or near the position where the change is intended. The result of such a diffusion is that the diffused substance whether or not together with the base material leads to a novel or changed property. It is also possible that diffusing itself gives novel or changed properties to the base material, in which the introduced substance itself does no longer make any essential contribution to said new or changed property. Said diffusion or injection roughly occurs along the field's electric field lines. The moving spirit behind this is a whether or not temporary increase of the conductivity, the capacity, or a combination of both, in said base material. When applying plastic as base material, as a consequence of this, ionomers can arise. Making an ionomer from a plastic by contacting an electrically conductive medium with said plastic and applying an electric field across the plastic surface is already known from the dutch patent application 91 00815, also by applicant. However, according to the invention, it has turned out that it is possible to also change other properties of such a base material, and furthermore, with numerous other base materials than plastics too.

With the invention, the electric field is not limited to a certain value. Furthermore, it can be a homogenous field or an inhomogenous field, such as it is caused by a needle electrode or conductive mercury droplet. The field-driven diffusion of substances to be diffused in base material already occurs at a field strength in the order of 1 millivolt/millimeter. The upper limit of the electric field is determined by the value, in which the intended product would be destroyed destructively. Here, the field can be a

direct voltage field, but for most applications, an alternate voltage field is preferred. For example, for salts as the substance to be introduced, it has been found, that the stronger the high-frequency field (up to about 50 kHz), the more effective the diffusion. Good results have been obtained with an alternating voltage field having a frequency within the range of 10 Hz - 25 kHz.

The invention can be applied with various types of base materials. Thus, the base material can be a synthetic or natural polymer. Further, the base material can consist of a ceramic or glass-like material. Particularly suitable, the invention is applied with a base material consisting of a composition of materials, comprising a multilayer system of substances, a fractal composition of substances, or a composite. It is also possible to apply the method according to the invention to an oil or fatty substance as a base material. Finally, the base material can also be a gel or a paste.

The electrically conductive medium primarily has to provide for, that the floating electric field is present on the location where an intended product having changing properties should be manufactured from a base material. Efficiently, the electrically conductive medium can be a liquid. This particularly has the advantage, that the specific substance, e.g. a salt, can be solved or suspended in the liquid. The electrically conductive medium can also be a gas or a gas plasma. Another possibility is a conductive rubber or paste. Finally, the conductive medium can also consist of a composition of conductive media.

In case of a conductive liquid as electrically conductive medium, the specific substance can be efficiently diffused in the base material directly from the liquid. In case of a gas or a gas plasma, the specific substance can also be introduced from one or more electrodes of the electrode system causing the electric field. Further, the specific substance can be applied on the surface or in one of the layers of the base material, through which said substance

must be diffused. In all of these cases, the electric field provides for an accelerated diffusion by which the intended effect and the desired property are achieved.

With the method according to the invention, it is possible to induce numerous novel properties in base materials. This concerns both physical, chemical and mechanical properties.

As for the physical structure, it has turned out that it is possible to apply a channel structure on micron and submicron scale in polyethene as base material and water as conductive medium, from which calcium salts are provided as the specific substance to be introduced.

As for the optical properties, it has turned out to be possible to introduce a light-diffusing area in various transparent substances within the base material. Further is has appeared possible, to diffuse specific substances in polyethene with the help of the electrically driven diffusion, in which said specific substances provide for, that the polyethene can be locally intensely coloured by a colorant. On the other hand, with other materials it will be possible to render a substance transparent according to the method of the invention with suitable production parameters. In some cases, the combination of change in physical structure is accompanied by the production of a polarizing optical effect.

As for the chemical properties, it has turned out to be possible to provide a polymer with active groups, that are capable of reacting with intruding other substances. The novel or changed physical and chemical properties can render base materials suitable for e.g. a membrane for gases or other substances. Thus, among other things, it has turned out that polyethene can be processed in such a way, that it does let water through, but no hydrated ions, for example. Further, polyethene can be processed in such a way, that certain gases can be intercepted, in that groups were introduced, with with said gases react. Thus, manufacturing of a

gas separation filter is possible. Another possible application is the manufacture of sensors e.g. changing colours or having other signal functions on penetration of certain gases or other substances.

As for thermal properties, an induced change of microstructure can increase the thermal insulation value, whereas the introduction of thermally highly conductive substances can render a base material better thermally conductive. By e.g. difussing salt in rubber as the base material with the help of an electric field it is achieved, that the base material will be better permeable to water en as a result of that will be better thermally conductive.

As for mechanical properties, the induced change in microstructure can bring about a desired change in the base material.

As for electric properties, apart from the preparation of monomers, as already known from the Dutch patent application 91 00815, the method according to the invention offers numerous further possibilities, such as affecting the conductivity, capacative action and the like.

As for magnetic properties, ferriferous substances and other magnetizable substances can induce novel or changed magnetic properties in a base material.

The substance to be introduced itself should induce a property directly or indirectly, or the introduction of the substance should induce a property directly or indirectly, or a combination of both should take place. An example of a substance inducing a direct property is copper sulphate with a polyethene as base material. Once present in said base material, the resulting material is capable of capturing hydrochloric acid gas, in which the sulphate is converted to bisulphate. An example of a substance indirectly inducing a property is a substance, such as copper ions, promoting the forming of oxidized groups such as carboxylate groups in a polymer as base material. An example of a substance in which the introduction itself induces the property, is a calcium

salt having e.g. polyethene as base material, in which microchannels are produced. The properties of said channels need no longer be related to the calcium salts themselves, but to the introduction thereof.

In case of the processing of a composed material as base material, the substance to be introduced can be penetrate from one of the layers of said base material into another layer of the base material, also when first-mentioned layer itself would not be indicated as the electrically conductive medium. An example thereof is the processing of a composed base material consisting of a layer of graphite with additives on a polyethene layer. After applying an electrically conductive medium on the surface of the graphite layer turned away from the polyethene, selected additives - after applying an electric field across the base material consisting of graphite and said polyethene - will be capable of penetrating the polyethene from the graphite layer, as a result of which the properties at the polyethene are changed. The previously mentioned copper or calcium salts could have been mixed into the graphite layer, for example.

The end product is generally in the form of a sheet or in the form of a coating across a carrier. However, it can also be a cylinder, hollow cone or spherical shape. With a composite base material, it can also be a network of a substance within another substance. Characteristic is the fact that an electric field must have been applied across the product once. However, after that, it can have been processed further, in which the geometry and the physical structure is changed further, An example is the introduction of terminal groups as carboxylate in a polymer. When the polymer is warmed up to near the melting point, the groups will become capable of classifying. At that moment, it is possible to deform the polymer. The physical structure of the polymer having terminal groups could also change in that the terminal groups become capable of clustering. Then, after cooling down, not only the polymer has obtained anot-

her macroscopic shape, the part having the terminal groups has been changed as well, and after heating, said part has other optical properties than before. Furthermore, crystal volumes can arise, that weren'nt present or possible before the heating. This has appeared in polyethene, in which carboxylate groups were introduced by means of above-mentioned process. After heating up to above 100°C and cooling down, a deviating recrystallization occurred.

Base materials that can be processed according to the indicated process can be: synthetic or natural polymers, ceramics, oil- or grease-like substances, gels, pastes, glass-like substances, rubbers, liquids, coatings, compositions of materials being multilayer systems of substances, plastics or composites.

The process can be applied to large objects such as ceramic surfaces, oil films and polymer foils. However, the process can also be applied on a microscopic or submicroscopic scale on inducing properties in micro electronics components, for example.

A suitable method of inducing novel or changed properties is to have the substance to be introduced diffuse into the base material from two sides. Here, among other things, the method according to the patent application previously mentioned can be adopted. There, a liquid electrically conductive medium was mounted at both sides of a gutter-shaped polymer foil by means of electrodes. However, other-base materials than polymers are contemplated too, such as gels and the like, and also polymers as base material, in which, however, the final material can not be characterized as an ionomer. A supply of the substance to be introduced from one side is also possible. The latter can occur in e.g. coatings or in composed materials.

Examples of applications of the materials prepared and systems combined according to the above-mentioned process include: membranes for filtering techniques for gases, ions, liquids; products having specific optic properties; half-

products in the chemical industry, suitable for follow-up reactions; substances having a built-in signal function for the presence of specific gases; magnetic plastics; obtaining adhesive layers in systems; releasing of layers; ion conductors; thermal conductors or insulators; chemical change or decomposition of oil films on water; obtaining layers and coatings having specific properties on or in components in the micro-electronics system.

- claims -

C L A I M S

1. Method of treating a base material for obtaining one or more specific properties by diffusing a specific substance into the base material, said substance directly or indirectly inducing the specific property or properties, **characterized in that** the base material is contacted with an electrically conductive medium, and that the specific substance is diffused into and/or reacts in the base material under the influence of an electric field being applied across the whole of said base material, electrically conductive medium and specific substance.

2. Method according to claim 1, **characterized in that** the electric field is a direct voltage field.

3. Method according to claim 1, **characterized in that** the electric field is an alternating voltage field.

4. Method according to claim 3, **characterized in that** the alternating voltage field has a frequency in the range of 10 Hz to 25 kHz.

5. Method according to one of the claims 1 - 4, **characterized in that** the base material is a synthetic or natural polymer.

6. Method according to one of the claims 1 - 4, **characterized in that** the base material is a ceramic or glass-like material.

7. Method according to one of the claims 1 - 4, **characterized in that** said base material consists of a composition of materials, comprising a multi-layer system of substances, a fractal composition of substances, or a composite.

8. Method according to one of the claims 1 - 4, **characterized in that** said base material is an oil or a grease-like substance.

9. Method according to one of the claims 1 - 4,

characterized in that said base material is a gel or a paste.

10. Method according to one of the claims 1 - 9, characterized in that the electrically conductive medium is a liquid.

11. Method according to claim 10, characterized in that the specific substance has been solved or suspended in the liquid.

12. Method according to one of the claims 1 - 9, characterized in that the electrically conductive medium is a gas or a gas plasma.

13. Method according to one of the claims 1 - 9, characterized in that the electrically conductive medium is a conductive rubber or paste.

14. Method according to one of the claims 10, 12 or 13, characterized in that the specific substance is introduced from one or more electrodes of the electrode system providing the electric field.

15. Method according to one of the claims 10, 12 or 13, characterized in that the specific substance has been applied on the surface or in one of the layers of the base material through which said substance is to be diffused.

16. Method according to one of the claims 10 - 13, characterized in that the electrically conductive medium consists of a composition of various conductive media.

INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION F SUBJECT MATTER
IPC 6 B01J19/12 B29C71/00 C08J7/18

According to International Patent Classification(IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B29C C08J B01J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 92 20728 A (KEMA NV) 26 November 1992 cited in the application see the whole document	1,3-5, 10-12, 15,16
X	PATENT ABSTRACTS OF JAPAN vol. 018, no. 234 (E-1543), 28 April 1994 & JP 06 028914 A (SONY CORP), 4 February 1994, see abstract	1,5,10, 11,15
X	US 3 652 244 A (PLUMAT EMILE) 28 March 1972 see the whole document	1,3,6,7, 10,11, 15,16

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[X] Further documents are listed in the continuation of box C.

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